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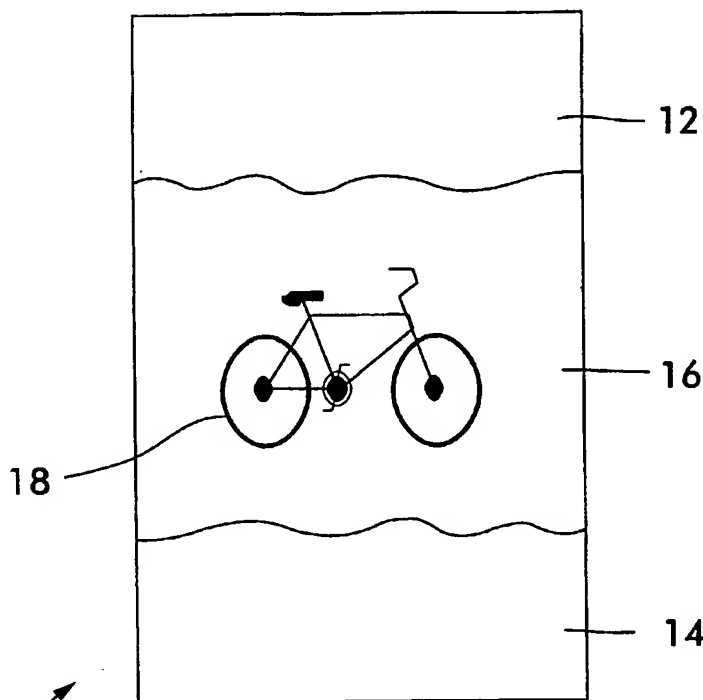
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(54) Title: IMAGE CARRYING LAMINATED MATERIAL



(57) Abstract: A method and apparatus for producing image carrying laminated material (10). An image (18) is printed on a polyvinylbutyral interlayer (16) using a solvent based ink, paint or dye system. The interlayer (16) is used to join two sheets of material (12, 14) to form the laminate.

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- 1 -

IMAGE CARRYING LAMINATED MATERIAL

Technical Field

This invention relates to the production of laminated material with an image that is visible from one or both sides of the material. The material may be made of any suitable substrate such as glass, polycarbonate, acrylic, cellulose acetate butyrate (CAB) or other thermoplastic resins. The image may take the form of a pattern, artistic work, written indicia or any other visually discernible form.

10 Background Art

Laminated materials, particularly laminated glass, have many applications as a construction material. They can for example be used to form windows, walls, doors and screens. They can also be used for the construction of articles such as coffee tables, and other small articles of furniture. Laminated materials are specified or desired in a number of applications as a result of their inherent safety characteristics compared to normal glass sheets. Laminated materials are typically formed by joining two sheets of material using a polyvinyl butyral interlayer or a polyether based aliphatic thermoplastic polyurethane interlayer, such as PE399 Krystalflex ® film, produced by Morton International, Inc., or the like. The production process normally involves two steps. In one step the interlayer is placed between the two sheets of material and heated as it passes through nip rollers that squeeze the sheets of material into contact with the softened interlayer. A further step involves the treatment of the laminate so formed in an autoclave to complete the bonding process.

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In many applications it is desirable to provide some form of image on the laminated material. The image can be for the purposes of decoration or can serve a functional purpose by partially or completely obscuring the view through the laminated sheet. Hitherto attempts to produce laminated material with images have presented serious practical problems. One way that an image has been formed on laminated material such as glass is by screen printing onto the finished

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- 2 -

laminated sheet. This is a cumbersome process and limits the images that can be produced both in colour and detail. For example a multi-colour image requires a printing step for each colour. Additionally the images can only be formed on discrete panels and for practical purposes this means that the images cannot be
5 formed in a regular manner so that the panels can be subsequently arbitrarily cut.

Other attempts have been made to place images on laminated material. These have taken the form of introducing an additional layer of some type that carries the image into the laminated sheet. This approach has the disadvantage of directly
10 interfering with the strength of the bond formed between the sheets of material. This is because the image carrying material results in a reduction in available area for bonding.

In another approach described in U.S. Patent No. 4,968,553 a printed
15 polyurethane sheet has been used to laminate two sheets of glass together to form an image carrying laminated sheet. The polyurethane sheet is printed with non-solvent-based inks so that there is no chemical reaction with the urethane. The commercial application of this process has been limited mainly due to the need for a polyurethane sheet rather than a conventional interlayer such as PVB.

20 Brazilian patent application 910 4893 describes an attempt to print directly on PVB interlayer. This application describes the use of an acrylic paint to form an image on the PVB prior to laminating. Acrylic paints have been found to have a significant detrimental affect on bonding between the interlayer and the adjacent
25 glass surfacing during lamination.

DISCLOSURE OF THE INVENTION

In one aspect this invention provides a method of producing image carrying laminated material including the steps of forming an image on a first surface of a
30 sheet of interlayer using solvent based ink, paint or dye systems, interposing the sheet of interlayer between two sheets of material, and joining the two sheets of

- 3 -

material to form the laminate by activating the interlayer.

In a second aspect this invention provides an image carrying laminated sheet including two sheets of material joined by an interlayer, the image being formed on
5 a first surface of the interlayer by solvent based ink, paint or dye systems.

In a third aspect this invention provides an interlayer carrying an image on a first surface formed using solvent based ink, paint or dye systems.

10 The joining step can include joining one or more additional interlayers to the interlayer bearing the image. In one form of the invention, an additional interlayer is joined to the image bearing interlayer on its image bearing face. In another form of the invention, additional interlayers can be joined to each face of the image bearing interlayer. Multiple interlayers can also be joined to each face of the
15 image bearing interlayers.

The interlayers are preferably joined to each other as part of the laminating process.

20 Preferably, the interlayer is formed from polyvinyl butyral. The interlayer may also be formed from a polyether based aliphatic thermoplastic polyurethane interlayer or the like.

In a further aspect this invention provides a method of producing image carrying
25 laminated material including the steps of mechanically stabilising a sheet of interlayer, forming an image on a first surface of the interlayer, removing the mechanical stabilisation, interposing the interlayer between two sheets of material and joining the two sheets of material to form the laminate by activating the interlayer.

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The joining step can include joining one or more additional interlayers to the

- 4 -

interlayer bearing the image. In one form of the invention, an additional interlayer is joined to the image bearing interlayer on its image bearing face. In another form of the invention, additional interlayers can be joined to each face of the image bearing interlayer. Multiple interlayers can also be joined to each face of the
5 image bearing interlayers.

The interlayers are preferably joined to each other as part of the laminating process.

10 It is also preferred in this further aspect, that the interlayers are preferably formed from polyvinyl butyral. The interlayers can also be formed from a polyether based aliphatic thermoplastic polyurethane interlayer, such as PE399 Krystaflex ® film. Preferably the image is formed on the interlayer using solvent based ink, paint, or dye systems. These systems may contain pigment and/or other additives.

15 In one strongly preferred form of the invention the image is printed onto the interlayer using a piezo electric drop-on-demand digital printing process. This process uses solvent based ink, paint or dye systems.

20 The mechanical stabilisation can in one form of the invention be achieved by using a mechanical connection between the interlayer and a removable membrane or substrate. The removable membrane can take any suitable form. The removable membrane can be a paper backing sheet adhered directly to the interlayer. The removable membrane can also be a suitable sheet material attached to the edges
25 of the interlayer in any suitable manner. The attachment can for example be achieved by adhesive tape. Suitable materials for the removable backing also include fibre reinforced vinyl. In some processes the mechanical stabilisation can be provided by an attachment to a component of the printing machine.

30 The removable membrane or substrate keeps the interlayer taut and allows it to be handled without deformation during the process of forming the image. Some of

- 5 -

the processes suitable for forming the image require the interlayer to be moved through a system at a consistent rate to prevent "banding and misses" in the printing. Additionally, many of the processes suitable for forming the image on the interlayer involve the use of heat. The interlayer is very heat sensitive and
5 typically loses much of its mechanical strength at temperatures of 60°C and above. The use of a backing membrane or substrate allows the interlayer to be handled in systems involving the use of heat without stretching or damage.

As will be appreciated by those skilled in the art the term "solvent based ink, paint,
10 or dye system" used in this specification refers to a system in which a colouring agent is carried in a suitable organic solvent or solvents. In the case of ink, for example, a pigment is dispersed in an organic solvent or solvents. These inks include so called "oil based" inks.

15 Use of solvent based ink, paint or dye systems to form the image on the interlayer has been found to not interfere with the bonding process between the interlayer and the sheet material. It is thought that this is a result of the solvent based ink, paint or dye systems etching into the surface of the interlayer and resulting in areas of the interlayer that are screened from and consequently not bonded to the
20 adjacent sheet of material. This is in contrast for example to acrylic based carriers for pigments which tend to pool and reticulate on the surface of the interlayer. This results in a region of the interlayer that cannot bond to the adjacent sheet of material and thus prevents a successful laminated sheet of material being formed.

25 In the case of solvent based inks and in particular oil based inks the organic solvent has been formed to provide a key for the pigment to bind firmly to the interlayer.

The use of additional interlayers in one form of the invention increases the bond
30 strength of the laminate. The additional interlayers may be joined to one face of the image bearing interlayer. This may be the face bearing the image.

- 6 -

Alternatively, additional interlayers may be joined to either face of the image bearing interlayer or both faces.

5 The additional interlayers are joined to the image bearing interlayer as part of the laminating process. That is, the interlayers (including the image bearing interlayer) are laid or stacked together between the sheets of laminate material, and so bond together when the entire interlayer-sheet sandwich is laminated.

10 In addition, it is believed that the additional interlayers may also protect the image from exposure to light, especially UV in sunlight. This may assist in inhibiting fading of the ink in the image, retaining the clarity of the image and increasing the longevity of the image in the laminated material.

15 Preferably, the image is allowed to cure on the interlayer before the interlayer is used in the lamination process. Depending upon ambient temperatures a curing period of up to 24 hours or more has been found to be beneficial in some cases. It is believed that the improvement is a result of additional solvent evaporation and possibly further etching of the remaining ink, paint or dye into the interlayer.

20 The image can be formed on interlayer of any appropriate type. For example the image can be printed on interlayers that are substantially transparent once laminated between two sheets. Alternatively, interlayers that are designed to be opaque or partially opaque through for example colouring can be used. Interlayers of any thickness otherwise appropriate for the laminating of the particular sheet material can be used. Commonly available interlayers are in multiples of 0.38mm in thickness.

The invention will now be further described, by way of example only, with reference to the accompanying drawings and examples

- 7 -

Brief Description of the Drawings

Figure 1 is a schematic elevation of a sheet of laminated safety glass according to a first embodiment of this invention showing layers partly cut away for illustrative purposes;

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Figure 2 is a schematic sectional view of the sheet of safety glass shown in Figure 1;

Figure 3 is a schematic elevation of a sheet of laminated safety glass according to a second embodiment of this invention showing layers partly cut away for illustrative purposes;

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Figure 4 is a schematic sectional view of the sheet of safety glass shown in Figure 3;

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Figure 5 is a schematic elevation of a sheet of laminated safety glass according to a third embodiment of this invention showing layers partly cut away for illustrative purposes;

Figure 6 is a schematic sectional view of the sheet of safety glass shown in Figure 5;

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Figure 7 is a schematic elevation of a sheet of laminated safety glass according to a fourth embodiment of this invention showing layers partly cut away for illustrative purposes;

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Figure 8 is a schematic sectional view of the sheet of safety glass shown in Figure 7;

Figure 9 is a schematic end elevation of a first printing machine used in performing the method of this invention;

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Figure 10 is an elevation of the printing machine shown in Figure 9;

Figure 11 is a schematic end elevation of a second printing machine used in
5 performing the method of this invention;

Figure 12 is a view similar to Figure 11 showing how the interlayer is fed to the
printer;

10 Figure 13 is a schematic end elevation of a third printing machine used in
performing the method of this invention;

Figure 14 is a schematic elevation of a fourth printing machine used in performing
the method of this invention;

15

Figure 15 is a schematic end elevation of the printer shown in Figure 14;

Figure 16 is an enlarged view of part of Figure 15; and

20 Figure 17 is a schematic drawing of the equipment and steps in a glass laminating
process.

Best modes for Carrying Out the Invention

The following description and examples refer to the manufacture of a laminated
25 safety glass product according to and using the method of the invention using PVB
interlayer. The invention is equally applicable to other laminated materials and to
the use of different forms of interlayer.

Figures 1 to 8 show four different embodiments of image carrying laminated safety
30 glass formed according to this invention. The processes for forming the image
will be described with reference to Figures 9 to 16 below and the laminating

- 9 -

process will be described by reference to Figure 17.

Referring to Figures 1 and 2 the laminated safety glass 10 is formed by two sheets of glass 12, 14 joined by a PVB interlayer 16 on which an image 18 is printed
5 using solvent based ink.

Figures 3 and 4 show a sheet of laminated safety glass according to a second embodiment of the invention. The same reference numerals have been used for corresponding features of the drawings. In this form of the invention two additional
10 PVB interlayers 20, 22 without printing are interposed between the interlayer 16 and the corresponding sheet of glass 12, 14. That is, there is a second sheet of interlayer 20 between the surface of interlayer 16 on which image 18 is printed and the sheet of glass 12 adjacent that surface. The third sheet of interlayer 22 is interposed between the surface of the interlayer 16 opposite the surface on which
15 the image 18 is formed and the sheet of glass 14 adjacent that opposite surface.

Figures 5 and 6 show a sheet of laminated glass according to a fourth embodiment of this invention. The same reference numerals have been used to identify corresponding features of the drawings. In this form of the invention a
20 single additional sheet of PVB interlayer without printing is interposed between the surface of interlayer 16 on which image 18 is printed and the adjacent sheet of glass 12.

Figures 7 and 8 show a sheet of laminated glass according to a fourth
25 embodiment of this invention. Again the same reference numerals have been used for corresponding features of the invention. In this form of the invention an additional sheet 24 of PVB interlayer has been printed with an image 18 using a solvent based ink. The interlayers 16 and 24 printed with images 18 are arranged adjacent each other and a further sheet of PVB interlayer 20 is interposed
30 between the surface of interlayer 16 on which image 18 is printed and the adjacent sheet of glass 12. The use of two interlayers 16, 24 on which images have been

- 10 -

printed spaces the images 18 apart and can be used to provide greater depth in the overall image presented when viewing the laminated safety glass 10.

Figures 9 to 16 show some of the ink jet printers suitable for use in the forming of the image on a PVB interlayer. In each case the printers are a wide format ink jet printer of commercially available type. It will be apparent to those skilled in the art that in order to use these machines to print an image onto any substrate suitable image data must be provided to the printer in a conventional manner. In most cases this involves firstly obtaining or preparing a digitised image. Suitable digital images can be produced on a conventional computer from a storage media such as a compact disc or by using conventional scanning technology to scan an original image. A suitable computer program such as Adobe® PhotoShop® is used to produce a postscript file. The postscript file can through suitable interfaces be used to provide the necessary data to the printer for reproduction of the image. In some cases additional software such as Postershop® RIP (Raster Imaging Processing) can be used for scaling and colour correction before outputting the necessary data to the printer for reproduction of the image. In the following description the features of four different printers and their use as part of the method for the present invention are described.

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Figures 9 and 10 schematically show the features of a large format ink jet printer known as an MMT (Metro Media Technologies International Inc.) paint jet system. This printer uses a large rotating drum 32 supported for rotation on an axle 38 by spokes 36. The frame of the printer is generally shown at the 34 and supports the drum in close proximity to a printing head 40 mounted on a carriage 42. As shown by arrow 46 in Figure 10 the carriage 42 moves the print head 40 in an axial direction in response to printer control (not shown). The print head 40 is driven in the conventional manner by the printer electronics (not shown).

30 In this process the PVB interlayer 16 is mechanically stabilised by being attached to the surface of the drum 32. This is achieved by laying the interlayer 16 on the

- 11 -

drum and taping the edges of the interlayer to the rotatable drum 32 using conventional adhesive tape shown in dotted outline at 44. It has been found that this attachment to the rotating drum component 32 of the printing machine 30 provides sufficient mechanical stabilisation of the PVB interlayer to allow accurate printing on the surface as the drum 32 is rotated adjacent the print head 40 in the conventional manner.

The ink jet printer 30 uses an MIBK uses a solvent based automotive paint using an MIBK (methy isobutyl ketone) solvent.

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Figures 10, 11 schematically show an Idanit® ink jet printer 50. The ink jet printer 50 is somewhat similar to that described in relation to Figures 9 and 10 in that a rotating drum 58 is supported by an appropriate axle 60. A frame made up of a bed 54 and upright 52 positions two printheads 56 adjacent the drum 58. In this case the drum 58 is perforated by a series of apertures (not shown) and a vacuum is applied to the interior of the drum. This vacuum is used to hold and mechanically stabilise the PVB interlayer 16. As shown in Figure 12 the interlayer 16 is loaded to the drum from a supply roll 16 by guide rollers 64. In most cases the leading edge of the interlayer 16 is initially taped to the drum 58 to prevent the interlayer coming into contact with printheads 56. Once a significant length of interlayer 16 is wrapped onto the drum the vacuum applied by the apertures (not shown) holds the interlayer in position for printing by the printheads 56 as the interlayer 16 is moved by rotation of drum 58 in the conventional manner.

25 The printer 50 uses any suitable solvent based pigmented ink.

Figure 13 schematically shows a piezo electric drop-on demand wide format Vutek 5300 digital printing machine. This machine is manufactured by Vutek Inc.

30 The printer 70 operates by passing the material to be printed over a series of rollers passed a printhead 90. The printer 70 holds the material to be printed

- 12 -

under tension between rollers 82 and 84 to provide a stable surface for printing. Because of the nature of the interlayer 16 it must be stabilised during the printing process. The stabilisation is achieved using a sacrificial web 72 which passes through the printer 70 with the interlayer 16. The sacrificial web 72 can be fibre-
5 reinforced vinyl or paper or any other material that does not stretch under moderate tension. In some applications the interlayer 16 can be taped to the sacrificial web 72. In others it is sufficient to pass the interlayer 16 and web 72 through the machine concurrently to provide the required mechanical stabilisation.

10 As shown in the drawing the interlayer 16 is supplied from a feed roll 74 which sits on two of three rollers 78. A sacrificial supporting web 72 supplied from a similar roll 76 that also sits on two of rollers 78. This ensures that the two materials are fed at approximately the same speed. The interlayer 16 and web 72 pass around
15 tensioning rollers 78 and 80 before passing around positioning rollers 82 and 84 between which the printing takes place. After passing roller 84 the interlayer 16, web 72 pass over a further roller 86 and a heating and drying surface 92 before being wound on a take up roller 88. The printer 70 tensions the web 72 to provide a stable surface for printing between rollers 82 and 84. The interlayer 16 is held against the web but the tension is maintained on the web 72 so that there is no
20 significant tension applied to the interlayer 16. This ensures that the interlayer passes in front of the printhead 90 without being stretched or deformed in much the same way as any other substrate resulting in accurate printing.

The printer 70 uses solvent based pigmented ink such as those available from
25 Inkwear Inc.

A suitable ink known as ULTRAVU-3 is available in the following colours:

	Cyan	Light Cyan
	Magenta IID	Light magenta HD
30	Yellow	Black
	Orange	Green

- 13 -

These inks contain ethylene glycol monobutylether acetate in an amount of up to 80%, cyclohexanone in an amount up to 20%, methyl-2-pyrrolidinone in an amount up to 10% (Light magenta HD) and other ingredients not disclosed by the manufacturer.

Another suitable ink produced for a similar machine, known as the Arizona printing machine includes the following components:

10	Ingredient name	Percentage
	2-Butoxyethyl acetate	up to 70%
	Propanol, 1 (or 2)-(2-Methoxymethylenethoxy)-, Acetate	up to 30%
	Carbon Black	1.0-5.0%
15	Vinyl Chloride-Vinyl Acetate Polymer	1.0-5.0%
	Acrylic Copolymer	1.0-5.0%
	NJ TS RN 121307-5038P	1.0-5.0%

Figures 14 to 16 schematically show a flat bed piezo electric drop-on-demand ink jet printer such as a Mutoh Falcon Jet 6100 from Eastech of Taiwan. The Falcon Jet 6100 is basically a standard Mutoh Falcon Jet 6000 which has a minor modification to the heads. The modification pre-heats the ink in the heads to change the viscosity of the ink and allow for proper flow of ink. This modification is necessary to use oil based inks in the printer.

25

As seen in the drawings the flat bed printer 100 has a frame 101 that supports an upper platen or bed 106. The interlayer 16 is stored on a supply roll 110 and is fed across the bed 106 to a takeup roller 112. The interlayer is moved by a pair of pinch rollers 102 and 104 positioned respectively above and below the interlayer 16 adjacent a printhead 108. The lower roller 102 is driven in a conventional manner to advance the interlayer 16 past the printhead 108 at a controlled rate.

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- 14 -

The positioning of the interlayer 16 on the flat bed 106 adjacent the pinch rollers 104 and 102 mechanically stabilises the interlayer for printing by the printhead. That is the interlayer is not under any appreciable tension and the desired accuracy of registration with respect to the printhead 108 can be achieved. This
5 allows a very high quality image to be printed on the interlayer at a 360 dpi or 720 dpi. The Mutoh Falcon Jet 6100 printer is normally provided with data from a suitable computer. In order to drive the printer the computer uses software such as Onyx® Postershop® to translate the postscript data to Raster Imaging Processing format for use by the printer. The ink used in the Mutoh Falcon Jet
10 6100 is supplied by Eastech and has the following composition:

	Dyestuffs	8%
	Ethyl Alcohol	30%
	Ethyl Acetate	8.5%
	Methyl Ethyl Ketone	7%
15	N-butyl Acetate	17.5%
	Ethycese Glycol Monmethyl	29%

Once the image has been formed on the interlayer by any one of the above techniques it is used to form a laminated glass sheet in the known manner. Figure
20 17 schematically shows the lamination process.

The laminating process involves moving a raw glass sheet stock 120 across a table 122 to a washing machine 124. The previously printed polyvinyl butyral interlayer is normally stored in temperatures of controlled humidity at a
25 temperature of around 6 to 7°C in a storage area 126. The glass sheets 120 are moved to a table 130 in a lay up room 128 where they are maintained in a clean environment. From there the sheets move to a transfer table 132 where a first sheet has the image bearing interlayer laid across its surface. A second glass sheet is placed on top of the image bearing interlayer in close alignment with the
30 first sheet to form a glass (image bearing) interlayer glass sandwich.

- 15 -

Alternatively, any required additional interlayers may be interposed between the image bearing interlayer and the glass sheets. For example, an interlayer can be laid on the first glass sheet, followed in succession by the image bearing interlayer, another interlayer and the second glass sheet. Thus, a glass-interlayer-
5 image bearing interlayer-interlayer-glass sandwich is formed.

The sandwich is moved through an oven 134 operating at a temperature of approximately 200°C before passing between nip rollers 135 exerting a pressure of around 10 bar. This results in the interlayer softening and bonding the two
10 sheets of glass together. The nip rollers ensure that there is no entrapped air in the laminated sheet. The laminated sheets so formed are then transferred to an autoclave which typically operates at a temperature of 135°C at a pressure of 11.5 bar. They are typically autoclaved for around 3.5 hours.

15 **Example 1**

Samples of laminated glass were prepared using a single 0.38mm thick PVB interlayer as described in relation to Figures 1 and 2. The glass sheets were 3mm thick. Samples were prepared with interlayer prepared using the printer and method described with reference to Figures 9 and 10 (Sample A) and Figure 13
20 (Sample B). Glass laminates were produced using the conventional laminating process described above. Both samples of resultant glass laminate had good lamination strength. The images on the interlayers were of excellent quality with no significant distortion evident.

25 **Example 2**

Samples of laminated glass were prepared from interlayer PVB interlayer printed using the drop on demand flat bed printer described in relation to Figures 14 to 16. The laminate was formed in accordance with the embodiment described with reference to Figures 3 and 4 (total three layers of interlayer – one either side of the
30 printed interlayer) using the conventional laminating process described above.

- 16 -

The following lamination image was of excellent quality with no significant distortion.

5 The samples were subjected to tests in accordance with Australian standard AS2208-1996 for laminated safety glass which include boil and fragmentation tests. These tests were performed on laminated glass sheets respectively having light medium and dark images printed on the interlayer. The darker images correspond to a greater amount of ink, paint or dye per unit area of the interlayer. In each case the samples were found to meet the Australian standard.

10

While some of the above examples made in accordance with the present invention met the Australian standard tests for safety glass or Grade A applications of laminated glass, the present invention is not limited to such applications. The present invention may be also used in other glass applications that are not
15 required to meet safety glass or Grade A standards.

In addition, and as mentioned above, while the examples described concern the production of laminated glass using glass sheets, it is within the scope of the invention to apply the invention to various other materials suitable for lamination,
20 such as polycarbonate, acrylic, CAB and other thermoplastic resins.

Sheets of different materials may be used in the production process to achieve the same result. For example, one sheet may be made from polycarbonate while the other sheet can be made from glass to form a polycarbonate-interlayer-glass
25 sandwich to be bonded to form a laminated sheet.

In addition, it is also within the scope of the invention to use suitable materials for the interlayer such as a polyether based aliphatic thermoplastic polyurethane interlayer or the like. For example, PE399 Krystalflex.® film may be used to form
30 the interlayer.

- 17 -

The foregoing describes only some embodiments of the invention and modifications can be made without departing from the scope of the invention.

- 18 -

CLAIMS:

1. A method of producing image carrying laminated material including the steps of forming an image on a first surface of a sheet of interlayer using solvent
5 based ink, paint or dye systems, interposing the sheet of interlayer between two sheets of material, and joining the two sheets of material to form the laminate by activating the interlayer.
2. A method as claimed in claim 1 wherein the step of joining said two sheets
10 of material includes interposing a second sheet of interlayer between the first surface and the sheet of material adjacent that first surface.
3. A method as claimed in claim 2 wherein the step of joining said two sheets of material includes interposing a third sheet of interlayer between the surface of
15 the interlayer opposite said first surface and the sheet of material adjacent that opposite surface.
4. A method as claimed in claim 1 including the step of forming respective images on first surfaces of at least two sheets of interlayer using solvent based
20 ink, paint or dye systems and interposing at least two sheets between said sheets of material.
5. A method as claimed in any one of claims 1 to 4 including the step of mechanically stabilising the sheet of interlayer during forming of said image.
25
6. A method as claimed in claim 5 wherein said image is formed by a piezoelectric drop-on-demand digital printing process.
7. A method as claimed in claim 6 wherein said step of mechanically
30 stabilising is performed by passing the interlayer through a pair of pinch rollers positioned adjacent a print head used in said digital printing process.

- 19 -

8. A method as claimed in claim 5 wherein said step of mechanically stabilising is performed by supporting the interlayer with a removable membrane during forming of the image.
- 5 9. A method as claimed in claim 8 wherein the interlayer is temporarily attached to the membrane.
- 10 10. A method as claimed in claim 8 or claim 9 wherein the membrane is selected from fibre reinforced vinyl and paper.
11. A method as claimed in claim 5 wherein the step of mechanically stabilising is performed by removably attaching the interlayer to a component of a printing machine.
- 15 12. A method as claimed in claim 11 wherein the component is a rotatable drum.
- 20 13. A method as claimed in any one of claims 1 to 12 wherein said sheets of material are glass.
14. A method as claimed in any one of claims 1 to 13 wherein the interlayer is polyvinylbutyral or polyether based aliphatic thermoplastic polyurethane.
- 25 15. A method of producing an image carrying laminated safety glass including the steps of forming an image on a first surface of a sheet of interlayer using solvent based ink, paint or dye systems, interposing with sheet of interlayer between two sheets of glass and joining the two sheets of glass by heating of the interlayer.
- 30 16. A method as claimed in claim 15 wherein said image is formed by a

- 20 -

piezoelectric drop-on-demand digital printing process.

17. A method of producing image carrying laminated material including the steps of mechanically stabilising a sheet of interlayer, forming an image on a first
5 surface of the interlayer, removing the mechanical stabilisation, interposing the interlayer between two sheets of material and joining the two sheets of material to form the laminate by activating the interlayer.

18. A method as claimed in claim 17 wherein said step of mechanically
10 stabilising is performed by passing the interlayer through a pair of pinch rollers positioned adjacent a printhead used in said digital printing process.

19. A method as claimed in claim 17 wherein said step of mechanically
15 stabilising is performed by supporting the interlayer with a removable membrane during forming of the image.

20. A method as claimed in claim 19 wherein the interlayer is temporarily attached to the membrane.

20 21. A method as claimed in claim 19 or claim 20 wherein the membrane is selected from fibre reinforced vinyl and paper.

22. A method as claimed in claim 17 wherein the step of mechanically
25 stabilising is performed by removably attaching the interlayer to a component of a printing machine.

23. A method as claimed in claim 22 wherein the component is a rotatable drum.

30 24. A method as claimed in any one of claims 17 to 23 wherein said image is formed using solvent based ink, paint or dye systems.

- 21 -

25. A method as claimed in claim 24 wherein said image is formed by a piezoelectric drop-on-demand digital printing process.

5 26. A method as claimed in any one of claims 17 to 25 wherein the step of joining said two sheets of material includes interposing a second sheet of interlayer between the first surface and the sheet of material adjacent that first surface.

10 27. A method as claimed in claim 26 wherein the step of joining said two sheets of material includes interposing a third sheet of interlayer between the surface of the interlayer opposite said first surface and the sheet of material adjacent that opposite surface.

15 28. A method as claimed in claim 17 including the step of forming respective images on first surfaces of at least two sheets of interlayer using solvent based ink, paint or dye systems and interposing at least two sheets between said sheets of material.

20 29. A method as claimed in any one of the claims 17 to 28 wherein said sheets of material are glass.

30. A method as claimed in any one of claims 17 to 29 wherein the interlayer is polyvinylbutyral or polyether based aliphatic thermoplastic polyurethane.

25

31. A method of producing an image carrying laminated safety glass including the steps of mechanically stabilising a sheet of heat softening interlayer forming an image on a first surface of the interlayer using solvent based ink, paint or dye, removing the mechanical stabilisation, interposing the interlayer between two
30 sheets of glass and joining the two sheets of glass to form the laminated safety glass by heating the interlayer.

- 22 -

32. A method as claimed in claim 31 wherein said image is formed by a piezoelectric drop-on-demand digital printing process.
- 5 33. An image carrying laminated sheet including two sheets of material joined by an interlayer, the image being formed on a first surface of the interlayer by solvent based ink, paint or dye systems.
34. An image carrying laminated sheet as claimed in claim 33 further including
10 a second sheet of interlayer interposed between the first surface and the sheet of material adjacent that first surface.
35. An image carrying laminated sheet as claimed in claim 34 further including
15 a third sheet of interlayer interposed between the surface of the interlayer opposite said first surface and the sheet of material adjacent that opposite surface.
36. An image carrying laminated sheet as claimed in claim 33 further including
at least one additional sheet of interlayer interposed between said sheets of
material with corresponding additional images formed on first surfaces of said
20 additional sheet or sheets by solvent based ink, paint or dye systems.
37. An image carrying laminated sheet as claimed in any one of claims 33 to 36
wherein said sheets of material are glass.
- 25 38. An image carrying laminated sheet as claimed in any one of claims 33 to 37
wherein the interlayer is polyvinylbutyral or polyether based aliphatic thermoplastic
polyurethane.
39. An image carrying laminated safety glass including two sheets of glass
30 joined by a heat softening interlayer, the image being formed on a first surface of
the interlayer by solvent based ink, paint or dye systems.

- 23 -

40. An image carrying laminated safety glass as claimed in claim 39 wherein the interlayer is polyvinylbutyral or polyether based aliphatic thermoplastic polyurethane.

5

41. An interlayer carrying an image on a first surface formed using solvent based ink, paint or dye systems.

42. An interlayer carrying an image on a first surface wherein the interlayer is
10 polyvinylbutyral or polyether based aliphatic thermoplastic polyurethane.

1/9

Fig 1

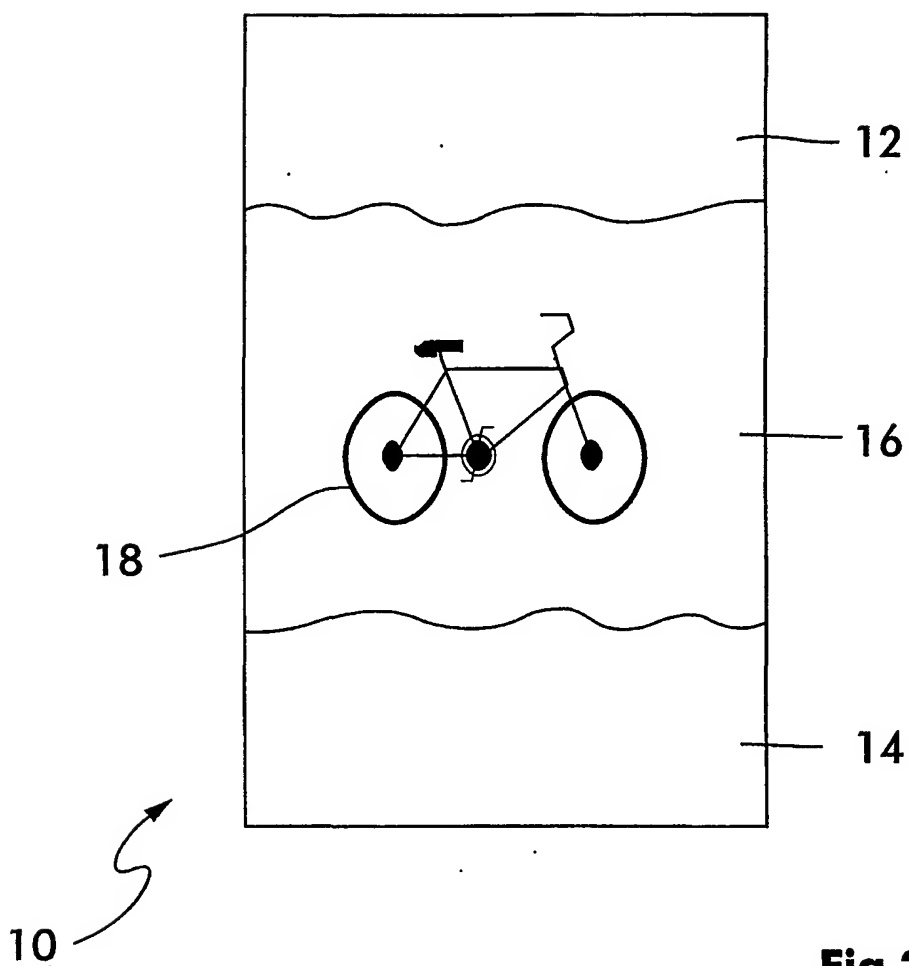
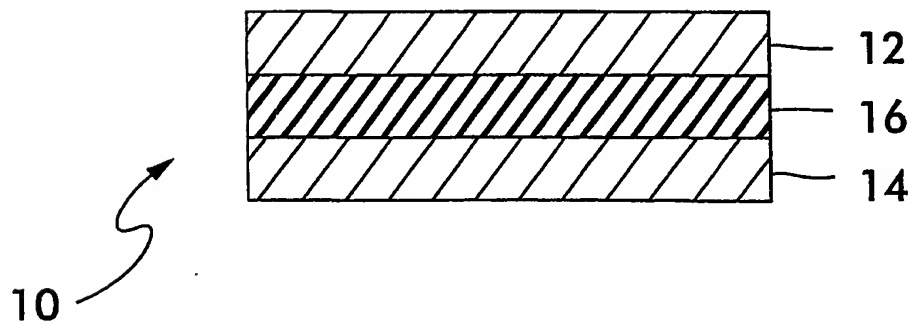


Fig 2



2/9

Fig 3

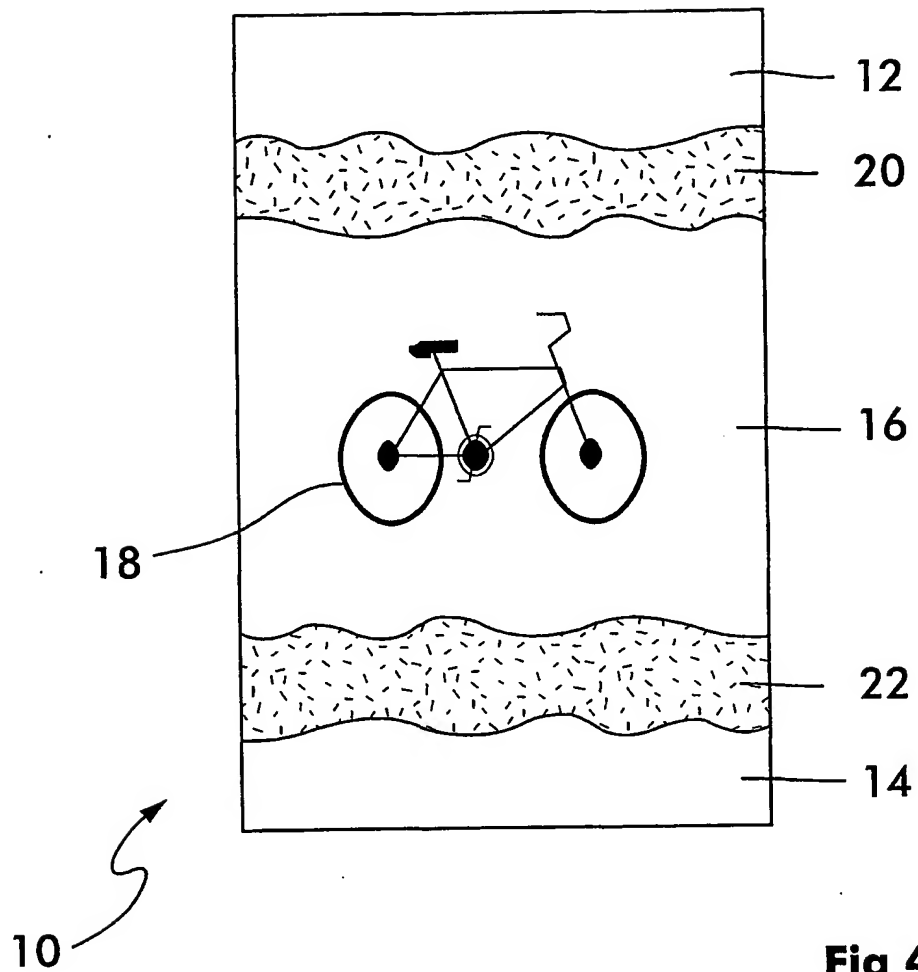
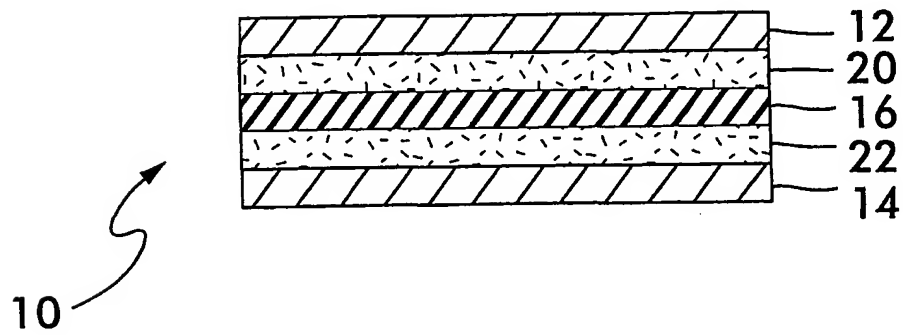


Fig 4



3/9

Fig 5

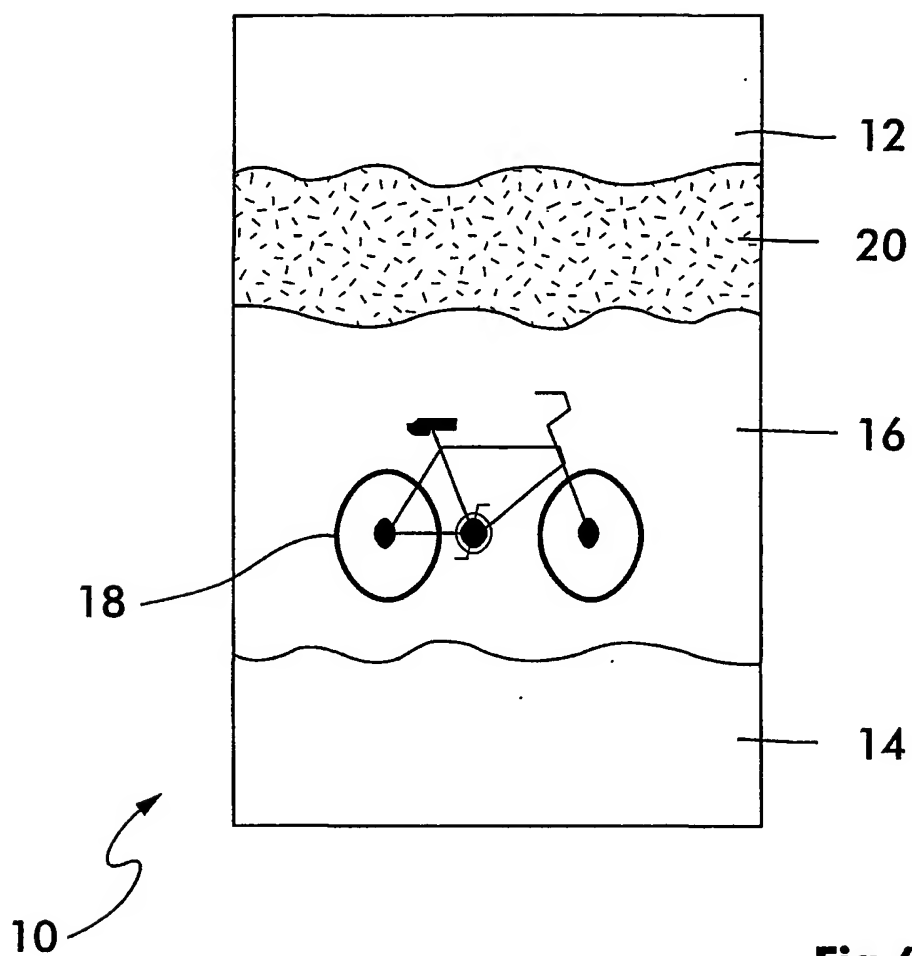


Fig 6

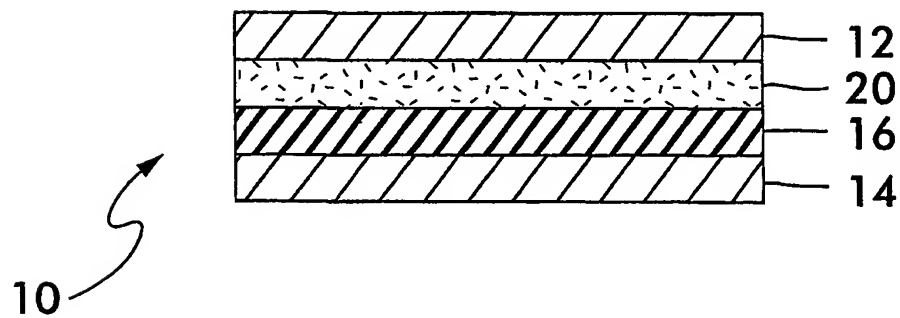


Fig 7

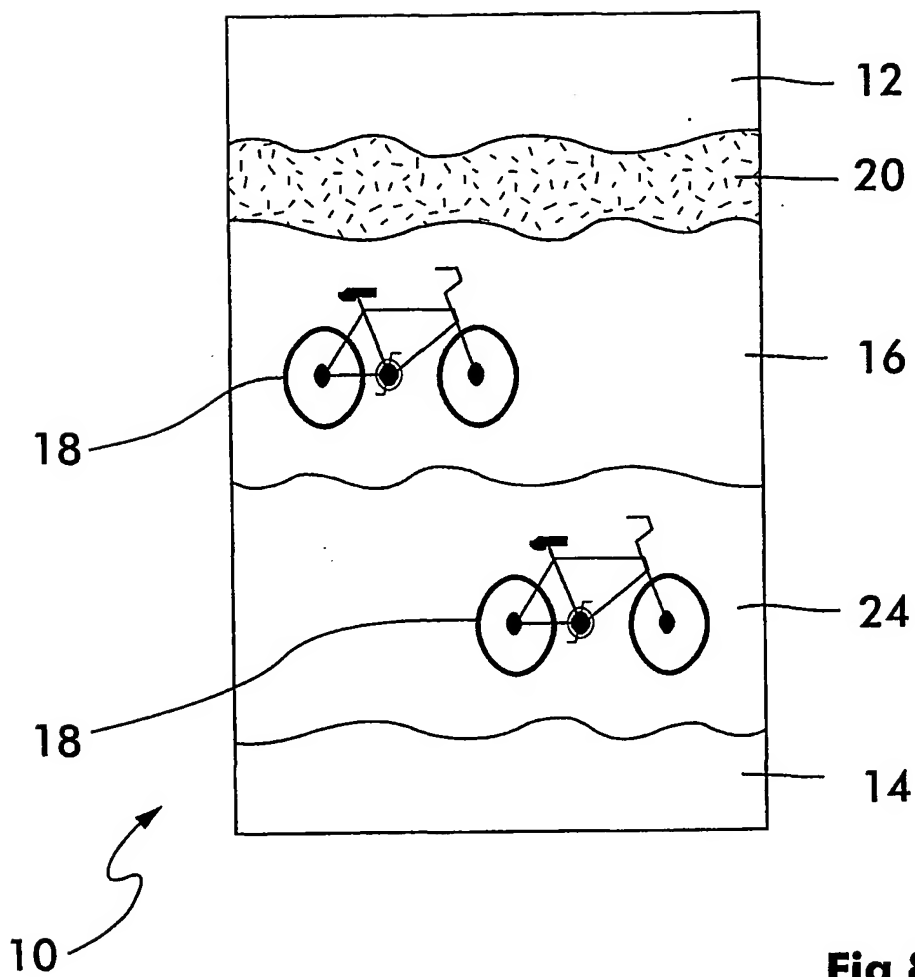
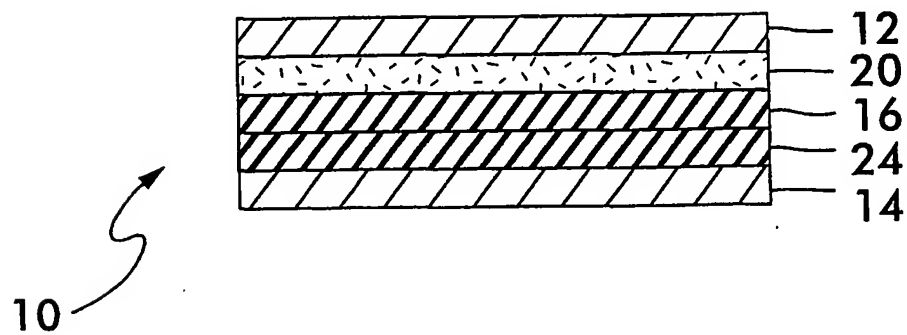


Fig 8



5/9

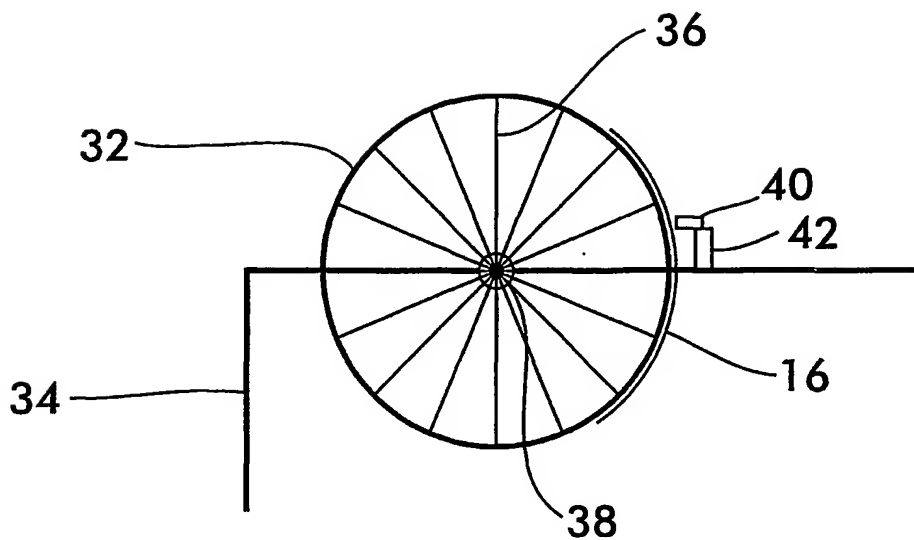


Fig 9

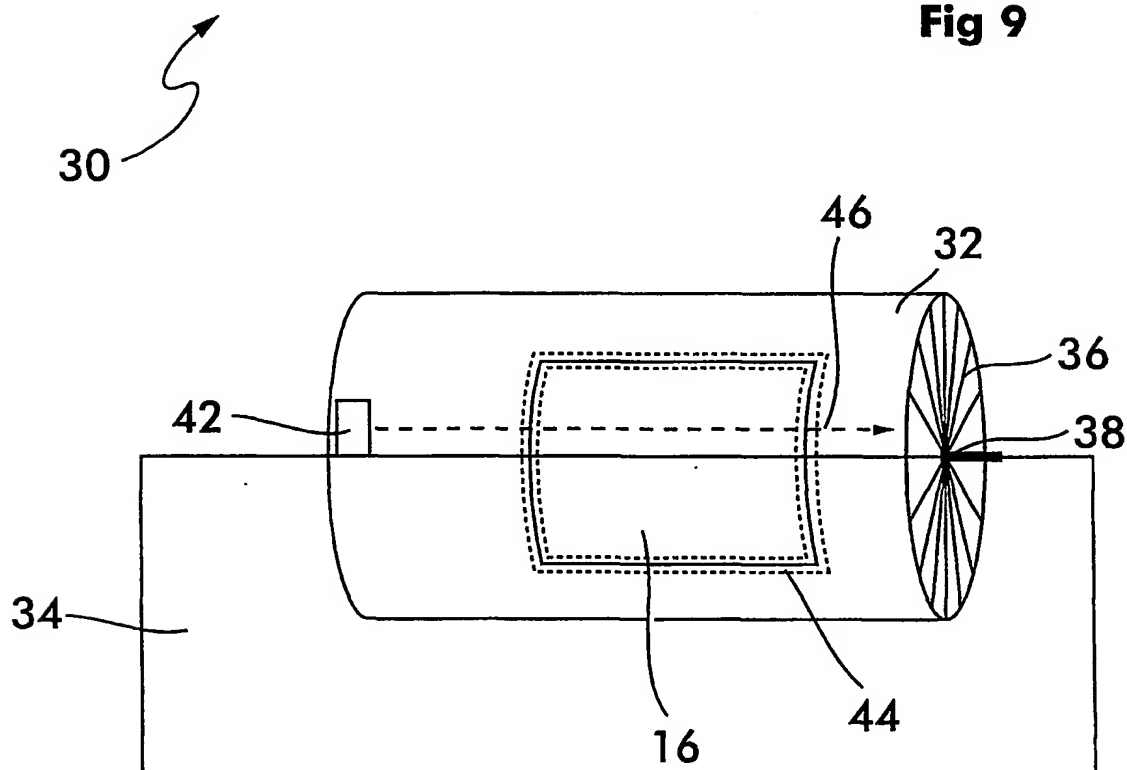


Fig 10

6/9

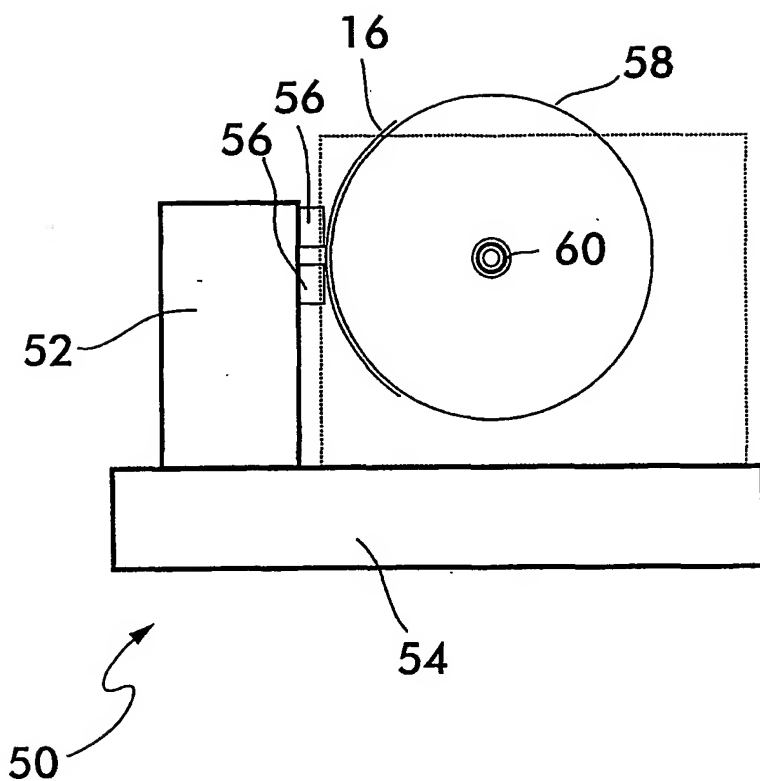


Fig 11

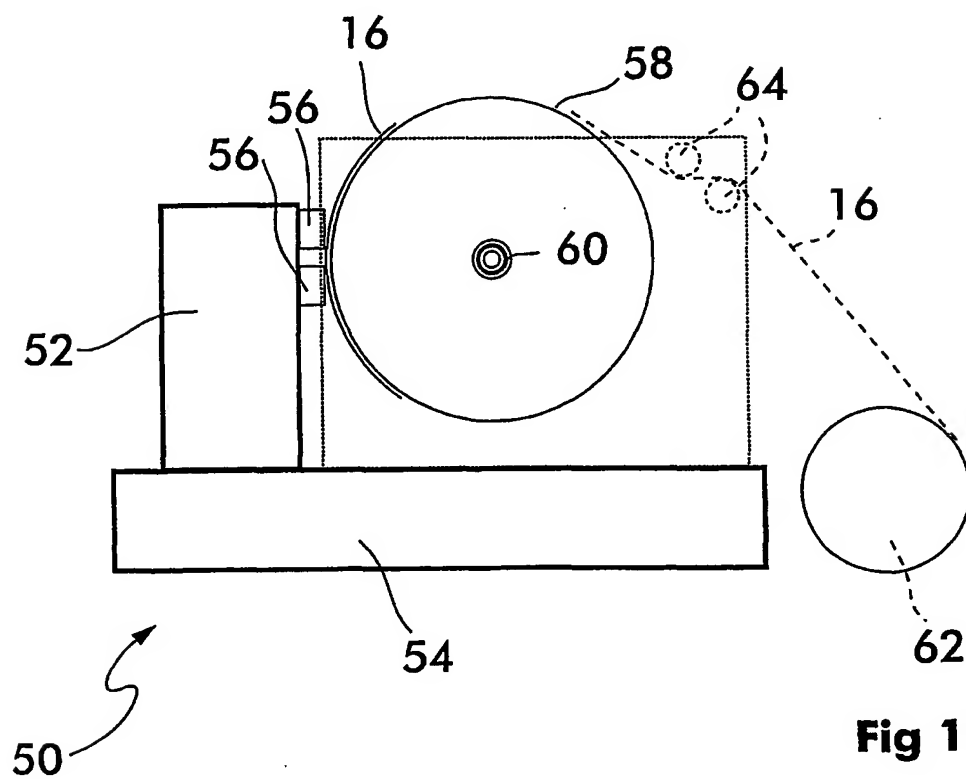


Fig 12

7/9

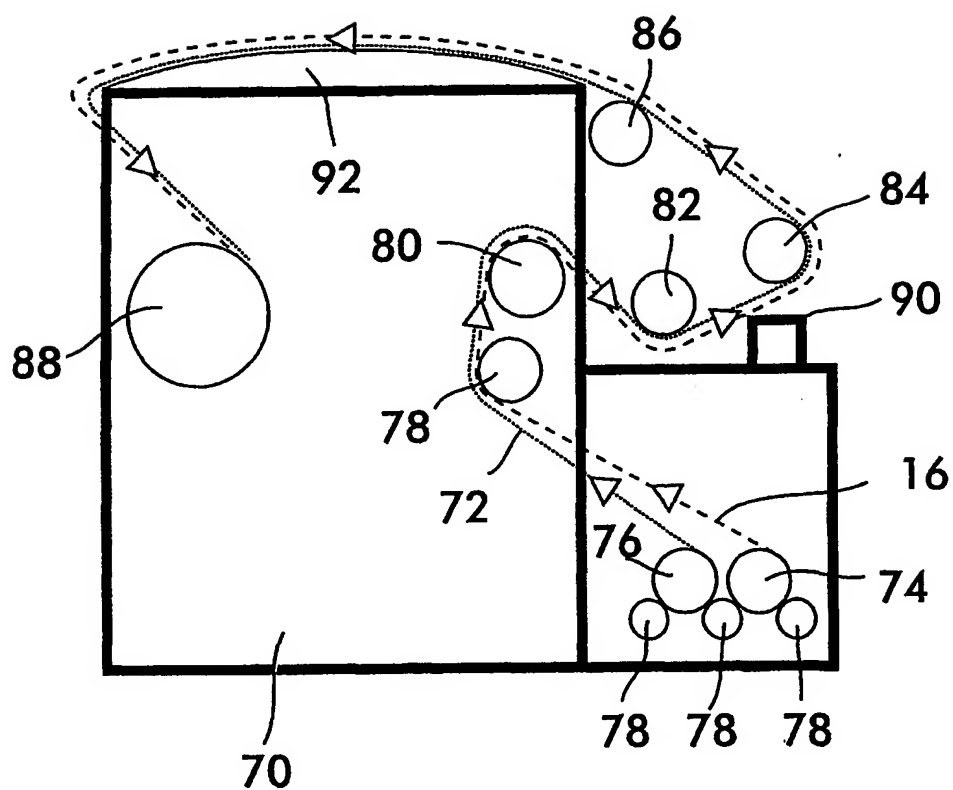
**Fig 13**

Fig 15

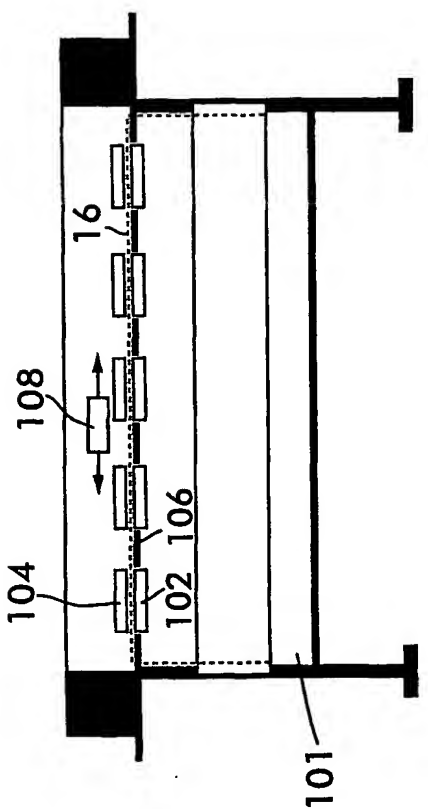
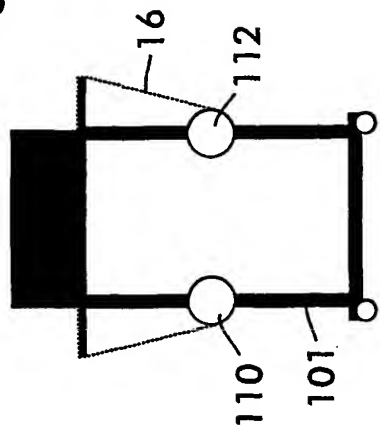
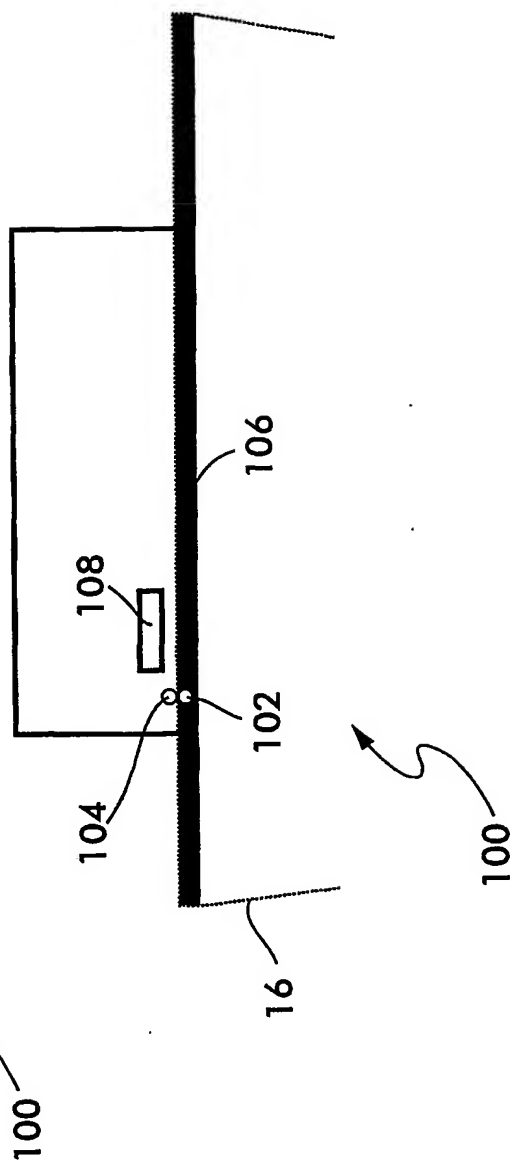


Fig 14

Fig 16



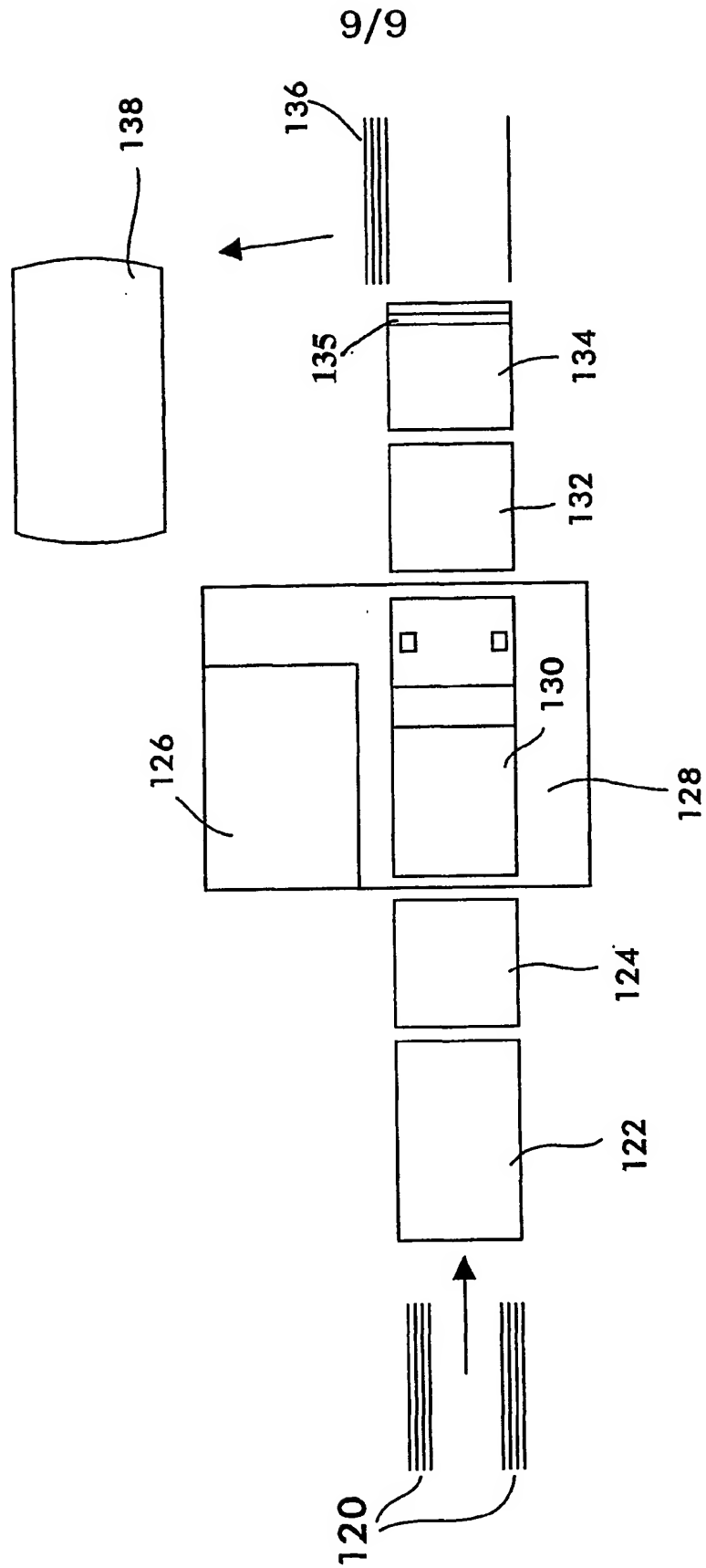


Fig 17

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU01/01106

A. CLASSIFICATION OF SUBJECT MATTERInt. Cl. ⁷: B44C 3/02, B32B 17/10, B29C 71/02, C03C 8/24, 27/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

REFER ELECTRONIC DATABASES BELOW

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DWPI :- IPC B32B, B41J, B29C, B44C 3/00, 3/02, B44F 1/-, C03C 27/-, 8/24 and Keywords (laminate, interlayer, sandwich, middle, inner, interposed, print, solvent, oil, image, indicia, activate, melt, heat)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4976805 A (ISHII et al) 11 December 1990 See columns 3-8 and abstract	1,5,13-15,17,24,29-31 33,37-42 2,8-10,34
Y		
X	US 4303718 A (SNELGROVE) 1 December 1981 See whole document	1,13-15,33,37-42 2,5,8-10,34
Y		
X	US 3973058 A (GROVER et al) 3 August 1976 See columns 2 and 3	1,13-15,33,37-42 2,5,8-10,34
Y		

☒ Further documents are listed in the continuation of Box C ☒ See patent family annex

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

26 October 2001

Date of mailing of the international search report

- 1 NOV 2001

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU01/01106

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 4173672 A (MANNHEIM) 6 November 1979 See whole document, particularly abstract See column 4 lines 18-34	17,19-21,26,29,30,42 2,5,8-10,34
X Y	US 4968553 A (CESAR) 6 November 1990 See whole document	17,22,29,30,42 2,5,8-10,34

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU01/01106

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
US	4976805	EP	319583	EP	593088
		WO	88/07027		US 6235140
US	4303718	NONE			
US	3973058	BE	836936	JP	51088311
US	4173672	AU	39569/78	BR	7805785
		CH	636558	DE	2837768
		FI	782720	FR	2401881
		IT	1111499	JP	54099179
		NL	7809053	SE	7809103
US	4968553	CA	2026530	EP	478836
END OF ANNEX					

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